

DIRECTOR OF CENTRAL INTELLIGENCE 2005 POSTDOCTORAL RESEARCH FELLOWSHIP PROGRAM (REVISED 1 MARCH 2005)

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1. INTRODUCTION

The Director of Central Intelligence (DCI) has established a Postdoctoral Research Fellowship Program within the CIA's Directorate of Science and Technology (DS&T), Intelligence Community Chief Technical Officer Staff. The DCI Postdoctoral Research Fellowship Program was created in response to the Intelligence Community (IC) requirement to address long-term IC research and technology needs. The Program serves the IC and research community by engaging experts in both areas in the solution of problems critical to IC goals and missions. Science and technology are fundamental drivers of global developments, and the DCI Postdoctoral Research Fellowship Program facilitates the necessary research in leading-edge technologies to support broad Intelligence Community technology needs.

The National Geospatial Intelligence Agency (NGA's) InnoVision Directorate is an executive agent for the university-based segment of the DCI Postdoctoral Research Fellowship Program. NGA's role as executive agent includes posting this Broad Area Announcement, managing the proposal review process, and using the Agency's grant authority to make awards in the program.

2. GENERAL INFORMATION

The Director of Central Intelligence (DCI) and the DS&T's IC Chief Technical Officer announce a Fiscal Year 2005 competition for the DCI Postdoctoral Research Fellowship Program.

The mission of the DCI Postdoctoral Research Fellowship Program is to establish long-term relationships and mentoring of postdoctoral researchers and to provide research institutes with an understanding of the Intelligence Community's research requirements. The program fosters partnerships with postdoctoral researchers as they move into career positions and provide innovative solutions to critical Intelligence Community problems.

Through this competition, the IC Chief Technical Officer expects to make awards in specific research topics. All awards will be based on merit competition. Depending on the quantity and quality of proposals received, the IC Chief Technical Officer may not make any award(s) under a particular research topic. If more funds become available, additional awards may be made at a later date based on initial evaluation results. Typically each award will be:

- For a basic period of one year (funded incrementally), with a potential option for a second and third year, and
- For the amount of \$120,000 per year/per grant.

This DCI Postdoctoral Research Fellowship Program competition is specifically for the research topics described in paragraph 8. Offerors are advised to read this announcement carefully. It explains the program research needs upon which the topics are based and the terms and conditions of this competition.

3. AREAS OF INTEREST

In paragraph 8, this BAA describes research areas, comprising some of the Intelligence

Community's most current technology interests. These descriptions provide offerors with a frame of reference and offerors are encouraged to submit innovative ideas that address these interests. Offerors also are urged to consider the research issues posed and, as appropriate, to contact the identified individuals to discuss potential efforts. Inquiries are welcome. Note that while technical contacts are listed for a topic, proposals must be submitted only to the addressees shown in paragraph 5.2.

4. CONDITIONS

The DCI expects that DCI Postdoctoral Research Fellowship Program projects will promote application of research primarily for intelligence purposes. The first phase of this competition was completed in November 2004 with an internal Call for Research Topics. The National Foreign Intelligence Program (NFIP) agencies - CIA, NGA, NRO, NSA and DIA (including NGIC, NAIC, AFMIC, CMO and others) – all identified Federal NFIP employees interested in making a commitment to serve as an Intelligence Community advisor (mentor) for a minimum of two years. Intelligence Community advisors submitted their resumes and proposed research topics that will draw highly-qualified Postdoctoral Fellows for Intelligence Community-related research. These research topics are listed in paragraph 8.

This announcement – the Call for Research Proposals – is the second stage of the Program Call and is a funding opportunity for qualified postdoctoral research investigators interested in research support in the specified topical areas.

Potential Fellows must be associated with an accredited U.S. university or college. **Each Postdoctoral Fellow must be a U.S. citizen.** The principal investigator / university mentor is **NOT** required to be an U.S. citizen.

5. SUBMISSION HIGHLIGHTS

The Government will evaluate all proposals submitted under the terms and conditions of this BAA. Government-paid consultants or subject matter experts may be involved in the evaluation and selection processes.

5.1. General

The IC Chief Technical Officer, through NGA as his executive agent, intends to award with FY2005 funding. To be considered and evaluated the Government must receive the full proposal by **1 April 2005**.

NGA will send the offeror an acknowledgment of receipt of the submission, and will follow-up later with a notification letter announcing whether the proposal is being recommended for an award. Acknowledgment and notification will be sent to the principal investigator via e-mail, according to the schedule in paragraph 9, with a copy to the appropriate university administrative office.

Proposals will be evaluated against criteria described in paragraph 6.1. The estimated grant start date identified in paragraph 9 should be used for budget and proposal

purposes. **You may, however, request a later start date and may therefore develop your budget based on your proposed start date.**

5.2. Submission

Proposals shall be formatted as one .doc file (or “zipped”.doc file) of a size not to exceed 1.95 Megabytes in total. The Government’s mail servers will not accept files of a greater size. The proposal shall reference BAA Number NGA501-05-BAA-0003. Proposals shall be submitted electronically by e-mail and simultaneously to Terri.A.Scheid@nga.mil and prfp05@westfields.net.

5.3. Content

Proposals must be complete and self-contained to qualify for review. Proposals shall be prepared single-spaced in 12-point Times New Roman font, with at least one-inch margins on top, bottom and sides, on 8½” by 11” paper.

The Intelligence Community is concerned with research in specific areas of science and engineering. For this reason, all proposals must adequately describe the technical objectives and approaches, support of principal investigator and Postdoctoral Fellow, and expenditures for equipment, all of which will be evaluated by qualified reviewers per paragraph 6. Separate attachments, such as institutional brochures or reprints that are not germane to the proposal, are discouraged.

The proposal shall include all of the following items.

5.3.1. Cover Page

The cover page shall include the BAA number (NGA 501-05-BAA-0003), proposal title, and topic or research area of interest. The cover page also must indicate the name, phone number, fax number, postal address, and e-mail address of both the principal investigator and an appropriate official in the university's research administration office.

5.3.2. Project Description

The project description portion of the proposal shall be limited to three pages and shall:

- A. Describe the proposed research objectives and approach to be undertaken. State the objectives and approach and the relationship to state-of-knowledge in the field and to similar work in progress. Include appropriate literature citations and prior work. Discuss the nature of expected results.
- B. Describe the expected outcomes and relevance to the Intelligence Community research need.

C. Identify other parties to whom the proposal has been/will be sent.

5.3.3. Resume

The resume shall be limited to two (2) pages each and shall provide the credentials of the principal investigator, demonstrating why the offeror is qualified to do the work proposed. If a Postdoctoral Fellow has been identified, an additional resume, two (2) pages in length, also may be included.

5.3.4. Cost

Beginning on a new page, the financial portion of the proposal should contain cost estimates in sufficient detail for meaningful review. The annual cost must be no greater than \$120,000. At least 50% of this cost should be allocated for direct support of one full-time Postdoctoral Fellow, including salary and fringe benefits. The remaining funds can be allocated to a fraction of the principal investigator's time, unique equipment needed to conduct the proposed research, other direct costs. University overhead will not exceed 10% of total proposal cost. For proposal purposes, use the later of the estimated award start date per paragraph 9 or the offeror's proposed start date. Exceptions to the above-recommended allocation will need to be approved by the IC Chief Technical Officer. The cost proposal must include the total cost of the project, as well as a breakdown of the amounts by source of funding (e.g., funds requested from the DCI Postdoctoral Research Fellowship Program, and/or institutional funds to be provided as cost sharing). The costs should be broken down for each year of the program and shown by three distinct totals: a total for the basic year and a total for each of the optional follow-on years. Although expected to be short, there is no page limit for the cost section of the proposal. Cost elements should include, but are not limited to:

- A. Time being charged to the project by the principal investigator and Postdoctoral Fellow, and their commensurate salaries and benefits.
- B. Costs of equipment based on most recent quotations and broken down in sufficient detail for evaluation (equipment costs should be budgeted primarily during the first year). Allowable equipment will ordinarily be limited to research equipment and apparatus not already available for the conduct of the work. General-purpose equipment, such as a personal computer, is not eligible for support unless primarily used in the actual conduct of the proposed scientific research.
- C. Travel costs and time, and the relevance to stated objectives. This shall include a breakdown of the name and number of travelers, location and duration; and estimated costs for transportation, rental car and per-diem. This shall also include travel for the required attendance at the annual DCI Postdoctoral Research Fellowship Program colloquium in the spring of each year. The FY 2005 colloquium will be held in the

Washington D.C. area on April 4-6, 2005.

- D. Other direct costs such as materials and supplies; publication, documentation and dissemination; computer services; communication costs not included in overhead; or others (identify). These costs shall include at least one published article per year in the Journal of Intelligence Community Research and Development (JICRD). This published article will need to be coordinated, vetted and submitted through the IC Advisor.
- E. Indirect costs.

5.3.5. Certifications

By signing and submitting any proposal under this BAA, the offeror is providing the:

- A. Certification at Appendix A to 32 CFR Part 25 regarding debarment, suspension, and other responsibility matters;**
- B. Certification at Appendix C to 32 CFR Part 25 regarding drug-free workplace requirements; and**
- C. Certification at Appendix A to 32 CFR Part 28 regarding lobbying.**

These certifications are located in Parts 25 and 28 of the DoD Grant and Agreement Regulation (DoDGARs), DoD 3210.6-R. This document is available electronically, under the heading “publications,” at the following Internet site: <http://www.dtic.mil/whs/directives/>.

The person who is authorized to provide these certifications should sign the proposal. Proposals submitted without signatures shall require a separate execution of the certifications. Also, it will be necessary for President, Vice-President, Chancellor, Vice-Chancellor, or Provost at the University to acknowledge that they are receiving CIA Funds.

6. EVALUATION CRITERIA AND SELECTION PROCESS

6.1. Criteria

6.11 The initial evaluation criteria used to determine if an offer is “selectable” are:

- A. The qualifications of the principal investigator and Postdoctoral Fellow (weighted 50%);
- B. Scientific and technical merits of the proposed research (weighted 30%);
- C. Relevance and potential contributions of the research to the Intelligence

Community's missions (weighted 20%); and

- D. The realism and reasonableness of cost, including proposed cost sharing. Evaluation of cost shall be based on cost realism as it relates to the Government's degree of confidence in the offeror's ability to perform the proposed work at the proposed cost (evaluated as pass/fail).

6.12 The final evaluation criteria are:

- A. The numerical score from the "selectable" evaluation.
- B. The potential contribution to the advancement of the targeted technical topic(s).
- C. The amount of similar or related research already underway on a given topic.

6.2. Proposal Evaluation Process

The Intelligence Community Advisors will independently review the proposals, evaluating them in accordance with all the evaluation criteria of paragraph 6.1 of this document, and completing a set of Evaluation Worksheets for each proposal. Proposals will be grouped together by specific research area. One expert team will evaluate all proposals in the same group. Out of all the proposals evaluated in the same group, the expert team will prioritize and recommend one or more proposals as they determine to be "selectable."

Next, all the recommended selectable proposals will be discussed by an Evaluation Panel consisting of the five NFIP agency points of contact, the NGA executive agent and the DCI Postdoctoral Research Fellowship Program Manager. The panel anticipates awarding a minimum of two grants to each NFIP agency (CIA, NGA, NRO, NSA, and DIA). The panel will convene and will consider the overall contribution of each 'selectable' proposal as reflected by the numerical score, the potential contribution to the advancement of the targeted technical topic(s), the amount of similar or related research already underway on a given topic and the amount of available funding. This step brings a cross-discipline balance to the selection process, reconciles recommendations about proposals spanning more than one technical area, and allows for strategic consideration of the diversity of proposals across the topic areas. While it is the panel's intent to make at least two awards to each of the five NFIP agencies, the final outcome may not reflect this intent. In summary, the combination of 'selectable' proposals that most effectively advances NFIP's academic research program will be recommended for award. The number of awards made is dependent upon the amount of available funding. If additional funding becomes available from within the community or from other U.S. Government agencies, the program may choose to make additional awards under the terms of this BAA from the remaining selectable proposals. The sponsoring organization will be free to support any 'selectable' proposal(s) that addresses the research interests of that organization.

The list of proposals recommended for award, along with a description and results of the evaluation process will be forwarded to the Director of Intelligence Technology Innovation Center (ITIC) for approval. When approved, the award list will be forwarded to the Contracting Officer for award action to include, as necessary, cost analysis and contract negotiation. Awards will be made upon successful negotiation.

7. AWARDS

Awards will be made for one year with two one-year options. The Government expects to exercise the first year option assuming quality research is ongoing. The second year option will be the exception, rather than the rule. The awards will be incremental funded at funding levels no greater than \$120,000 per year, per award/option period.

Notification announcing whether or not the offeror's proposal is being recommended for an award will be e-mailed directly to the principal investigator. Awards are expected to be in place by the proposed start date or the start date identified in paragraph 9, whichever is later.

Once a proposal is selected for award, one of two scenarios will be executed:

- A. If a postdoctoral candidate is already identified and prepared to begin the proposed research, 100% of the first year's award funding could be provided by the start date.
- B. If a qualified postdoctoral candidate must be sought, \$10,000 of the award amount will be provided initially, with the remaining first year's funding provided when the qualified candidate is identified and selected by the university.

8. SPECIFIC RESEARCH TOPICS FOR FY05 DCI POSTDOCTORAL RESEARCH FELLOWSHIP PROGRAM

The 30 topics that follow topics represent Intelligence Community's research interests that are particularly suited for investment this year. An award in any topical area will be made only if a sufficiently meritorious proposal is received. The IC Chief Technical Officer reserves the right to allocate available funds among topics based on the quality of the responses and priorities. A detailed description of each topic with Point of Contact (POC) data is presented in following paragraphs.

8.1. Topic withdrawn 1 March 2005

8.2. Mass Communication Research for Detecting and Analyzing Media Campaigns

POC: Timothy Thomas, 703-613-8275 (CIA)

Background

The IC, along with its partners in the White House, the Department of State and the DOD, is charged with countering orchestrated, foreign media campaigns that are aimed at preventing the USG from accomplishing its foreign policy objectives. In order to fulfill this mission, it is necessary to detect, dissect, predict, and in general understand how these campaigns are designed, managed, executed and to assess the effectiveness of the various techniques they employ.

Media campaigns are akin to negative political campaigns, aggressive advertising efforts, and marketing aimed at capturing market share from competitors. The techniques and strategies used in these private sector activities have been the focus of much dedicated scientific study. The IC seeks to leverage this existing pool of talent and experience to help devise effective techniques for defending our Nation against the negative impact of these centrally planned, funded and executed foreign media campaigns.

Researchers in Mass Communication have at their disposal a host of proven scientific techniques to facilitate their analyses. These include surveys, focus groups, statistical sampling of the media environment, authorship analysis, content analysis, media analysis, psychological studies, and cultural anthropological research. The USG, and particularly the IC components, have an important opportunity to improve application of these modern methods. Proposals are sought in areas that include, but are not limited to, the following: stratifying unfamiliar target populations to identify the intended target audience of the campaign being analyzed, determining which levers of influence are being manipulated in particular socio-political situations, uncovering the use of subtle cultural iconography, collecting meaningful samples of the information environment, uncovering the beliefs and attitudes which make the target susceptible to the message, and measuring the likely impact of particular media events.

8.3. Cyber Technology Revolution: Alteration of Production, Social Dynamics, and Access to Resources

POC: Michael Warner, 703-482-3118 (CIA)

Background

The world may well be undergoing a transformation in social dynamics, methods of production, and access to resources and information that is comparable to the Industrial Revolution. Like the Industrial Revolution, however, the transformation is not happening in a straight, linear fashion. As science fiction writer William Gibson reportedly quips, “The future is already here; it’s just not evenly distributed yet.” We can see people and groups who are far into that future (i.e., who routinely experience and participate in the emergence of a “networked world”), as well as others who have only begun to travel that path. Looking at what we can already observe about the changes fostered by the spread of what we might call “the cyber revolution,” what can we say about how that transformation is occurring in ways that should interest or will affect America’s security?

The goal of this project is to gain greater insight into how changing patterns of thought, behavior, and interaction are affecting the knowledge and wealth-creation aspects of the cyber revolution. Just how are computerization, miniaturization, and instant networked, global communications altering peoples’ personalities, perceptions of self and others, beliefs, work, and social interaction in ways that must ultimately have a bearing on the topics and methods of intelligence work?

- We hope to support research that increases our understanding of what is happening or has happened in the places and social sectors that have been leading the cyber revolution so that we can anticipate what will happen elsewhere as much of the world follows the transformation over the next generation. We are interested in how people will act and what they will expect in a more fully networked world, and how their changing outlooks are themselves pushing the spread and refinement of cyber transformation.
- For the purposes of this project we are not particularly interested in details like shifting consumer tastes, the economic indicators of the computer industry, or the science behind possible breakthroughs in processing capabilities. Rather, we want to comprehend the larger forces and trends shaping the future so that we see how the emergence of a networked world will affect the US Government, particularly the Intelligence Community and its mission to promote the national security.
- Possible research areas (mentioned simply as illustrations and not as requirements or limits on a project proposal) might be:
 - Do people behave differently on-line? What studies and data (as opposed to anecdotes) do we have on the issue?

- Is the wider diffusion of global databases helping or hindering the spread of knowledge? For example, are the restrictions placed on access to data trivial or serious, and what effects are they having in terms of creating “gated” communities of interest, or even fostering a culture of data theft (one contention in the struggle over music/video downloads)?
- How is the speed of computing and communicating changing perceptions of time, particularly in terms of shifting the balances in the classic economic and social trade-offs (such as speed v. accuracy)?
- Is networking creating global communities of interest that are more emotionally, intellectually, and even spiritually appealing than ties of family, clan, nation, or humanity? Should we expect shifts in loyalty to non-state actors, for instance, or new loyalty from people around the world who hitherto were not fully represented by the hostile states in which they live?
- Does the spread of “cyber behavior” inevitably give rise to an anti-social reaction, and could that reaction (i.e., hacking, spying, sabotaging, and even terror) grow to proportions that will paralyze the global network?

8.4. Susceptibility of Bioelectronics to Electromagnetic Pulses

POC: Stephen Bachowski, 937-257-6716 (DIA)

Background

Sensors, data fusion, data processing, communications and other electronic devices are critical to successful military operations. Damage or malfunction of these systems could lead to mission failure. Recently, the Secretary of the Air Force, James Roche, directed the formation of a Directed Energy Task Force to examine “Directed Energy Impacts and Implications for Future Air Force Operations” (Ref SAF Memorandum 18 AUG 2004). This threat is not unique to the Air Force; the DoD and Department of Homeland Security also have similar concerns. There are two critical issues at stake: 1) Can our directed energy weapons be countered in the battlespace? and 2) Can we protect our critical electronics from directed energy attacks? This proposal will focus on the radio frequency weapon threat.

Radio Frequency weapons have received much attention recently and may be a detriment to future military operations. Standard computers and electronics have become increasingly susceptible with increased miniaturization and chip density. Likewise, the development of electromagnetic pulse weapons assumes future systems will be vulnerable targets. Thus determining the susceptibility of future electronic technologies is paramount. Two future technologies may nullify this threat: bioelectronics and opto-electronics. Bioelectronics will be addressed in the current proposal.

Biotechnology represents a recent technology that may provide a counter measure to radio frequency weapons. Bioelectronics (a.k.a. bio-hybrids, bio-memory, bio-computing, biosensors, molecular electronics, conducting polymers) have emerged as a revolutionary technology for small, light weight, low power systems. Unlike their semiconductor counterparts, the susceptibility of bioelectronics to transient electro-magnetic pulses has not been fully characterized. The reasons semiconductors present a radio frequency vulnerability are not mirrored in biologically based devices (Ref “Opportunities in Biotechnology for Future Army Applications 2001”). Therefore, knowledge of these phenomena will contribute to mission success and national security.

A search of the scientific literature reveals no direct evidence of research in this arena. This is not surprising since bioelectronics is a relatively new field. Data does exist on protein interactions with x-ray and electron sources at cryogenic temperatures (Gary & Timucin NASA Ames Research Center 1997 bacteriorhodopsin memory) but this does not include electromagnetic pulse effects. Goal: Show experimental evidence to determine susceptibility of bio-electronic components against radio frequency pulses and an initial assessment to drive future research.

TECHNICAL OBJECTIVES and GOALS

1. Establish baseline susceptibility data using standard electronics (ref IEEE Transactions on Electromagnetic Compatibility Vol 46 No 3 August 2004—provides illustrated example)
2. Select representative bio-electronic devices (logic circuits, bio-FET, memory storage, conducting polymers, Reed-Torr Molecule switches, electro-active polymer as EMP shields, etc) and run comparative test
3. Determine basic parametric data changes (using bio-devices or systems) on electro magnetic pulse (EMP) exposure (IV curves, voltage switching ratios, memory storage, etc); reset vs. failure rates and destruction rates

PROPOSAL: Address experimental setup and equipment; selection & source of bioelectronics/molecular electronics and experimental protocols & analysis

8.5. A Distributed Cognitive Information Processing System

POC: Peter Bythrow, 703-907-0282 (DIA)

Background

Embedded systems technology has reached the level at which it is practical to deploy numerous low-power wireless computation and sensing devices with the capacity to execute demanding algorithms. The military forces, as well as the Intelligence Community, can utilize these devices

to sense and understand the environments within which they operate. This capability could provide a significant enhancement to existing Measurement and Signatures INTelligence (MASINT) systems. We propose to develop a robust platform for distributed, pervasive, small computing devices to implement a cognitive information processing system that understands its surroundings and responds to changes in its environment by constantly evaluating and adapting its behavior. The novel contributions of the proposed work fall into the following categories: (1) adaptive, error-tolerant, and intelligent correlation and analysis of heterogeneous but related observations from different sensors, and (2) dynamic, low-energy, environment-aware distribution of computation within the wireless, ad-hoc network of nodes.

This network can address objectives such as, the (1) collaborative localization and tracking of multiple moving targets; (2) cognitive target sensing via 3D views and target recognition, will be undertaken during the first year. Arbitrarily positioned video and acoustic sensors will be initially considered.

Research Proposal

We propose to address the challenges of the first objective above by: (1) intelligent fusion of multiple sensory inputs to enhance the robustness of the system, and (2) collaborative and distributed tracking by reducing and balancing the computational load among sensors. The novelty of our approach lies on the use of (1) multiple sensor fusion based on a Dynamic Bayesian Network (DBN) which provides a powerful, intelligent, and cognitive learning framework, and (2) Collaborative and Distributed Monte Carlo (CDMC) tracking methods for establishing the collaboration among multiple computational units. Based on our prior work, we plan to develop the most suitable DBN structures and training algorithms for the proposed system.

Once the target is localized and tracked, prominent visual features from different views are identified and their correspondences are established, based on which the 3D geometry can be reconstructed. Clearly, a major challenge is the construction of visual correspondences among different views, since some visual features may be contaminated by noise or even completely occluded in some views. In addition, the establishment of this correspondence is required for large baseline camera configuration. Based on our prior work we propose to develop a Bayesian network, which provides an explicit top-down model for the occlusions. Techniques for shape-based recognition will be developed. The large local shape deformation within each class will be addressed with the establishment of a statistical model that captures and learns the variations of the deformation through training examples. Clearly pre-trained target models will not be accurate in all working scenarios. Thus, an intelligent cognitive system, i.e., a system that it can train itself based on automatically collected unlabeled data, is proposed to be developed.

Regarding the dynamic clustering of sensors, we propose to extend our prior work on the use of information utility functions to define the set of active sensors over a finite time window subject to a constraint on the energy consumption.

8.6. Molecular Virology and Epidemiology of Foot-and-Mouth Disease Virus

POC: Jim Kvach, 301-619-7511 (DIA)

Background

Development of global temporal-spatial models of molecular changes in Foot-and-Mouth Disease Virus (FMDV); an understanding of temporal-spatial changes in the FMDV genome sequence is a fundamental prerequisite in Foot-and Mouth Disease (FMD) surveillance and modeling systems. These systems need to project rates of global movement of FMDV strains to anticipate new strains for use in vaccines, to predict when and where new strains will emerge and spread, and to identify anomalous or unpredicted strains that may have been the result of man-made strains or accidental transport of the virus. FMD surveillance systems and models must be able to address how the virus genome changes over time and from one geographic region to another. Efforts to incorporate molecular information about FMDV into surveillance systems and models will require a rigorous and complete assessment of the literature pertaining to known strains of FMDV reported worldwide, as well as knowledge of the forces that influence nucleic and amino acid sequence changes and development of new strains. Temporal and geographical changes in the molecular make-up of FMDV must be incorporated into models developed to project when and where new strains will appear, the nature of the change (site and impact of sequence changes expected), and factors that may explain why the changes occurred.

Research Proposal

The Postdoctoral Fellow (PDF) will critically review the literature for all known strains of FMDV in the world and will develop and maintain a comprehensive information database for all strains and related demographic, clinical, geographic, and temporal data. The Postdoctoral Fellow will work with FMD modelers to identify time-space clusters, geographic direction and rates of strain movement, rate and molecular direction of strain change, identification of hypothesized factors that may influence direction and rate of change (e.g., host species, vaccination strain types), and manifestation of strain change (i.e., more severe clinical disease in ruminants, increased neonatal mortality, alterations in detection/diagnostic assay efficiencies). The PDF must work with modelers to develop strategies for optimal global deployment of sampling and testing devices (see below), given various FMD incursion scenarios throughout the world.

The PDF will be involved in the adaptation of a current FMDV real-time RT-PCR (RRT-PCR) assay for use in commercially available autonomous air sampling devices, such that the sampling and testing will be accomplished on-sight and in real-time by the device, including remote electronic reporting of results. The overall goal is to develop a fully automated and validated diagnostic system for field use in sampling and testing of the environment, with emphasis on air-sampling, for FMDV. The PDF will participate in optimization and field validation of an existing FMDV Reverse Transcriptase Real-Time Polymerase Chain Reaction (RRT-PCR) assay directed at all 7 serotypes of FMDV.

8.7. Applications of Quantum Computers

POC: Lori Steinbrunner, 937-257-2573 (DIA)

Background

Quantum computers differ from traditional computers in that they use the superposition principle to allow simultaneous computations to occur. Whereas parallel data processing methods allows the same type of computation, the quantum computer will provide this capability on a single piece of hardware, at much higher speeds.

Quantum computers are projected to be available in 15-20 years but industry experts say it could be “one creative idea away.” Currently, there are only a few known algorithms that have been developed that will benefit from the development of quantum computers. Best known to date is Schorr’s algorithm to factor large numbers for cryptographic use. However, algorithms that may appear inefficient or impractical for use on traditional Von Neuman computers could be practical and highly efficient if run on quantum computers. Testing and evaluation could be accomplished now with immediate implementation upon the availability of quantum computers.

One area in which the development of quantum computers may offer some benefit is multi-sensor data fusion (MSDF). MSDF utilized the data from various sensors to develop a single track against a potential target. For MSDF to work properly, the data from distributed sensors must be passed to a fusion center, in a timely and efficient manner, where it will be combined to generate a single track file. It can be computationally challenging to combine the large amounts of data transmitted to the fusion center from the multiple, distributed sensors.

Because quantum computers can perform simultaneous computations, it would appear that multi-sensor data fusion is an example of an application that would see improved results when implemented on a quantum computer.

Research Proposal

Technical Objectives

1. Review literature on quantum computing and identify the types of applications that will benefit from the development of quantum computers.
2. Examine potential algorithms and identify baseline characteristics specific to quantum computing.
3. Re-evaluate potential applications, to include, but not limited to, potential benefits of quantum computing to MSDF.

Goals:

- To establish a baseline set of characteristics that will allow identification of algorithms applicable to quantum computing.
- To determine if MSDF algorithms could be made more effective or efficient

through the use of quantum computers.

8.8. Methods and Techniques for Training Intelligence Professionals to Perform Scientific and Technical Intelligence Analysis

POC: William C. Lindahl, 937-257-6301 (NASIC)

Background

The Intelligence Community (IC) must continuously ensure that its Scientific and Technical Intelligence (ST&I) professionals are of the highest caliber and expertise. The opportunity and challenge is to develop a training methodology that builds on the technical expertise of scientists and engineers and ensures that they have the critical thinking skills and tools they need to fulfill the IC's requirement for qualified S&TI professionals. This training would empower scientists with the "art" of intelligence analysis. At the same time, it would benefit non-technical specialists, advancing their understanding and appreciation of the role of existing and new technologies in military and civilian affairs.

Research Proposal

The goal of this proposal is to advance technical intelligence by developing new, more effective training methodologies. Possible research may include an examination and extension of the ideas and strategies from the fields of technical and higher education. Proposals are sought that design a course of instruction to address the following issues:

- Content – Determine the nature of successful analysis and the knowledge, skills, and abilities analysts need to succeed. Consider the importance of the cognitive and perceptive dimensions of intelligence analysis.
- Materials – Discover innovative and effective tools for teaching analysts how to approach problems that involve a high degree of uncertainty and misdirection. This may involve research in human factors, and industrial and cognitive psychology.
- Presentation – Discover optimal methods for presenting the materials and teaching the intelligence trainee. This may involve research into computer-based training concepts, individual learning styles, and the effects of prior training, education, and environmental factors.

Possible outcomes from this research include a white paper or thesis describing the research in these areas. It also could describe the practical application of the results in the form of a syllabus and manual of instruction. The emphasis will be on the "who, what and how" of instruction so that the methodology can be applied to specific intelligence disciplines in a consistent fashion.

8.9. Enabling Technologies for Robotics

POC: Greg Moore, 703-874-4913 (ITIC)

Background

The Intelligence Community has an interest in small ground mobile systems and their enabling technologies. Such systems would likely have many of the characteristics of small animals or insects and could weigh on the order of a few hundred grams or less.

Research Proposal

Specific proposals are sought in the following areas:

- Understanding of the mechanisms of adhesion, self-cleaning, and release used by climbing animals and insects and applying those principles to climbing and perching robots;
- Efficient linear actuators with exceptional power, stroke and bandwidth characteristics in small form factors appropriate for insect-like robots;
- Methods for integrating sensors, actuators, and other system components into smart appendages for robots;
- Modeling and simulation techniques that help to answer the general question: “Can a given robot traverse a given terrain?” Issues such as ground-robot interaction and characterization of deformable terrain are of particular interest; and,
- Development of system design technology that incorporates human cognition as a system component for remote multi-level supervisory control of robot interaction with the world.

Multiple awards are anticipated in this area. Proposals that involve collaboration among DCI Postdoctoral Fellows are encouraged.

8.10. Audio Research

POC: Greg Moore, 703-874-4913 (ITIC)

Background

The Intelligence Community has historically relied on a variety of methods for collecting audio information. These methods involve more than simply emplacing a sensor and listening. Useful intelligence emerges when all elements from sensor characteristics to storage to analysis and transcription of the recorded voice are part of a well-considered plan.

Proposed Research Topic

Audio signal analysis and characterization is one area that could benefit from new insights and research. Specifically, proposals are sought in the following areas:

- **Detection of Voice in Noise:** Translators/transcribers can be more effective if we can reduce the amount of irrelevant information that they must review. There are essentially two ways to accomplish this. The audio can be analyzed after collection to detect voice activity, or methods can be devised to ensure that only voice is collected. Thus, better methods to detect voice in the presence of noise such as engines, fans, music, etc., and the ability to identify a specific individual from voice in noisy environments are of interest.
- **Intelligibility of Speech:** Speech intelligibility is environmentally sensitive, language dependent, and subjective. Most research has focused on automated speech recognition for the consumer market. We are interested in the data mining aspect of the problem: once audio is collected, we need to sort through it to determine if the content is worthwhile. This does not imply translating all collected audio, but rather the prioritization of large amounts of collected audio by identifying key words and utterances. An understanding of how speech intelligibility is affected by environmental and electronic constraints may enable better designs that provide audio that is more readily prioritized and transcribed. Research proposals that employ panel studies in concert with modeling and simulation are of particular interest

8.11. Improving the Ease of Use of Iris Recognition Biometric Systems

POC: Andrew Kirby, 703-874-0834 (ITIC)

Background

Biometrics-based authentication and identification systems are being implemented at an increasing rate in government and industry for multiple security applications. Iris recognition holds particular promise as a reliable image-based biometric given the uniqueness and long-term stability of the iris pattern. However, iris recognition systems have yet to gain widespread use owing to various limitations, one of which we believe is ease of use. In addition, only a modest number of iris recognition algorithms and systems have been commercialized whereas there are many different face recognition algorithms and systems available, although their performance is not always adequate for the particular security requirement. The ultimate goal of this effort is to make iris recognition “effortless.”

Research Proposal

The sponsor is particularly interested in innovative hardware or software approaches or concepts for iris recognition that lend themselves to greater “ease of use.” In particular, we are most interested in proposals that address improvements in one or more of the following areas:

- Increasing enrollment/verification range
- Reducing enrollment time
- Reducing iris-image acquisition/verification time

- Reliable segmentation of the iris from the raw image
- Ability to process iris images when the iris is in motion
- Ability to process iris images when the subject is not looking directly at the imager

Therefore, the primary objectives the proposed research must be among the following:

1. Examine the key means to improve iris recognition systems in terms of ease of enrollment, ease of verification (both authentication and identification).
2. Propose and demonstrate effective means to acquire iris images at ranges of about two meters and beyond with minimal inconvenience to the subject being imaged.
3. Objectively evaluate the performance of alternative iris recognition algorithms against a standard set of raw iris images.
4. Develop and demonstrate improved or alternative iris recognition algorithms that afford ease of use advantages and/or other performance advantages.
5. Develop and demonstrate successful hardware and software implementations of iris recognition systems with vastly improved ease of use.

However, any proposed effort must also include delivery to the sponsor of a prototype or a bench-top working model, both hardware and software (where appropriate), of the improved iris recognition system or module.

Given the complexity of implementing an entire iris recognition system, the proposal may focus on any subset of the above objectives 1 - 5. Proposals will be ranked according to their innovation, realism, and technical depth, based on the prior experience of the advisor or proposed post-doctoral candidate, and based on responsiveness to the goals and guidance specified above.

8.12. Improving the Security of Fingerprint Recognition Systems

POC: Andrew Kirby, 703-874-0834 (ITIC)

Background

Biometrics-based authentication and identification systems are being implemented at an increasing rate in government and industry for many different security applications. Fingerprint recognition systems are widely deployed as authentication tools to automate the control of both logical and physical access to sensitive resources. However, popular accounts in the literature indicate these systems are vulnerable to spoofing, particularly in unattended implementations. For critical applications, the potential vulnerability of fingerprint recognition systems must be reduced. Therefore, the fundamental objective of this research is to improve the security of fingerprint recognition systems by eliminating the known and anticipated vulnerabilities of these systems in unattended implementations.

Research Proposal

The sponsor welcomes proposals that relate to any or all of the following:

- Novel, inherently less vulnerable techniques to acquire fingerprint images
- Novel fingerprint recognition algorithms with less vulnerability to attack
- Novel means to prevent logical replay attacks
- Novel means to prevent physical replay attacks

A competitive proposal will also include:

A means to objectively demonstrate the superior security of any new technique to acquire fingerprint images.

A means to demonstrate that the match performance of a more secure imaging technique is as good or better than existing automated fingerprint match systems.

Delivery to the sponsor of a prototype or a bench-top working model, both hardware and software, of a security-enhanced fingerprint recognition system

Proposals will be ranked according to their innovation, realism, and technical depth based on the prior experience of the advisor or proposed post-doctoral candidate, and based on responsiveness to the goals and guidance specified above.

8.13. High-Resolution 3-Dimensional Through Media Imaging

POC: Daniel Cress, 703-874-0700 (ITIC)

Background

The objective of this proposal is to explore the science, sensor technology, and signal processing of through-media imaging with particular emphasis on novel sensing and signal processing techniques for obtaining 3-D high-resolution images inside media.

High-resolution through-media imaging techniques are limited by attenuation of energy in the media, potentially modest differences in reflectances or attenuation of the priority internal targets, and general scattering by the media. It is assumed here that the state-of-the-art imaging includes one-sided and full-access tomographic techniques. For example, Terahertz electromagnetic imaging is often times limited by internal scattering by media scattering centers with the result that increasing power or signal integration time enhances the noise response as well as the target-of-interest response.

Research Proposal

Under this proposal, there is particular interest in the identification of new techniques for discriminating the response of targets and suppressing the noise response within media. Example concepts of interest include mixing of multiple sensing modes within the same or differing energy waveforms to take advantage of general target or media characteristics. For example, if the targets of interest tend to be quasi-linear conductors and the scattering backscatters in the media tend to be random, to what extent can polarization techniques be used to enhance the target and suppress the background? What are potentially different characteristics for target categories relative to media (e.g. conductance, attenuation, polarization reflectance)? Would it be possible to mix distinctly different energy propagation modes in some spatially coherent manner to isolate scattering at a specific depth in the media in order to suppress the otherwise contributing scattering interactions from other depths? For example, could a spatially-coherent interaction between physical vibrations such as ultrasonics and simultaneous electromagnetics be identified for excitation geometries for which the signals from these interactions can be highly localized?

Applications would be solicited for a postdoctoral research fellowship in experimental, signal processing, or theoretical aspects of the above topic with emphasis on target enhancement and media response suppression within the image construction. The successful applicant would communicate with participants in the ITIC-led Terahertz research team. The applicant would be expected to set up his own project, relevant to and compatible with team interests, under the guidance of and with assistance from senior team members. The objective of the fellowship will be to significantly advance the state-of-the-art in imaging in attenuating, scattering media.

8.14. Novel Imaging Technologies: THz Detector Device Development & Theory for Terahertz Biomolecular Spectroscopy

POC: Ted Wackler, 703-874-2355 (ITIC)

Background

The terahertz region of the electromagnetic spectrum has the potential to address many areas of concern for assuring national security. Imaging and spectroscopy technologies are two areas of particular interest to the Intelligence Community. We are open to terahertz research in general and have a particular interesting the following areas:

- **THz Detector Device Development:** Practical Terahertz Imaging will require fast parallel recording image plane technology, along the lines of CCD image plane technology for optical imaging. Various technologies have been demonstrated for single pixel THz detectors, but little has been done to try to develop multiple pixel image plane detectors. We invite interested investigators to propose novel schemes for multiple pixel, near video rate image plane systems for any or all frequencies from 0.3 THz to 1 THz, which could be built and tested

in a two-year project,

- **Biomolecular Spectroscopy:** Development and exploration of advanced theoretical methodologies is needed to model and predict Terahertz (THz) spectra obtained from experimental measurements of complex biomolecular and chemical systems that generate low frequency, far-infrared and neutron spectra. Exploratory studies conducted with THz and neutron spectroscopies have shown that THz detection generates very complex low-frequency spectra of solid and liquid-state systems that arise from atomic internal and external phonon mode motions. Many spectra of specific amino acids, small sugars and larger polypeptides have been reported, but assignment of specific atomic molecular modes requires advanced solid-state theory for interpretation of the results. In order to better understand the origin of features measured by our approach, new theories and precision modeling are required to explore and compare predicted spectra to measured ones.

We intend to fund at least one proposal in the Imaging Technology area, and may fund additional proposals.

8.15. Spectrally Adaptive Nanoscale Sensors

POC: Susan Durham, 703-874-4264 (ITIC)

Background

Hyperspectral and multispectral sensors are in great need for a variety of applications ranging from monitoring chemical agent production facilities to identifying geographical terrain. By obtaining the spectral response of the agents in different wavelength bands (e.g., multi/hyper spectral imaging, MSI/HSI), image-analysis capability and detection probability can be greatly improved. However these systems are fairly bulky and expensive. Advances in Nanotechnology offer potential solutions to these drawbacks.

Research Proposal

The proposed effort intends to develop spectrally adaptive focal-plane arrays, based on nanoscale quantum dots (QDs), in the mid-infrared regime (3-14 μm). Arrays assembled by these properties will be more compact than equivalent sensors which lack QDs, improving performance. The spectral agility will be obtained using electro-optics and will not involve moving parts such as passive filters. The goal is to produce sensors that can perform real time applications and have sufficient spectral resolution to differentiate between materials of interests in this spectral region, such as different types of geological rocks and select gases.

8.16. Quantum Dot Stability and Emission Efficiency

POC: Frank Gac, 505-665-1131 (ITIC)

Background

Nanocrystal quantum dots (QDs) comprise potentially ideal optical markers for tagging a variety of physical assets. QDs of specific composition and size can be prepared to emit across a broad spectral region. Further, emission is efficient (quantum yields as high as ~100% have been achieved) and spectrally narrow. Absorption is efficient (large extinction coefficients) and broad, making QDs equally accessible by either broadband excitation or single-wavelength excitation, the latter of which can be any wavelength at higher energy than the QD absorption edge. Lastly, QDs are processed chemically into a variety of liquid and solid matrices. While preparations are available for making efficient infrared emitting QDs, substantial materials deficiencies remain that preclude immediate application of these materials.

Research Proposal

Proposals are sought which focus on several materials development issues and specifically discuss a means for controlling the environmental effects on QD infrared emission properties that currently lead to unpredictable “off-the-shelf” properties. Further, while quantum efficiencies in emission are typically high (>25%) for QDs emitting at wavelengths <2 microns, efficiencies for emission above this (into the mid-infrared) are generally lower. Therefore, means for achieving high efficiencies in the mid-infrared also will be considered. Lastly, matrix incorporation and its impact on QD properties should be addressed. Together, a solution of these key materials chemistry issues is expected to result in efficient, robust, and flexible QD materials.

8.17. Next Generation Graph Data Management System and Query Language

POC: Dan Adams, 703-735-3873 (NGA)

Background

Arc-node graphs are used within the intelligence community to represent information ranging from the concrete (e.g., lines of communication and telecommunications intercepts) to the abstract (e.g., social networks and analysts' hypotheses). As intelligence problems become harder and as collections increase, the problems associated with managing and exploiting these data become ever more daunting. The enormous scale (>10⁹ nodes, multiple terabyte databases of relationships and attributes) is just the first hurdle. Update, modification, and query performance are all issues that are limiting the usefulness of today's graph data management systems. Beyond these infrastructure issues there is a need to take a fresh look at the query mechanisms and query languages available for extracting information from these graph data.

Research Proposal

This topic calls for research to make significant theoretical, yet implementable, advances in creating a next generation graph data management and exploitation system.

8.18. Mathematical Theory Applied to Complex Systems in Social Networks and in Brain Structure

POC: Jeffrey Kretsch, 703-735-3159 (NGA)

Background

The Intelligence Community is faced with the need to understand very complex systems encountered in its work with social networks. Similarly, neuroscientists are working towards understanding the complex interactions of neurons within biological neural systems. This understanding of neural systems would also benefit the Intelligence Community because it could form the basis for developing advanced analysis tools with selected computational properties of biological brains. A similar mathematical basis appears to apply to both social networks and the structure and interactions of neurons in the brain. Further research in this field is desired under this topic.

Research Proposal

Areas of exploration might include graph theory, network theory, information theory, cognitive science, adaptive systems, and related emerging areas; and applying knowledge and techniques from these areas to the problem of explaining how complex structures might arise from simpler underlying basis elements. In addition to neurons in the brain, the nodes and connections may represent people and social interactions, molecules and their interactions, or web pages and hyperlinks.

Focused research further developing theory in this area, including psychophysical experiments and computational modeling, is desired for eventual application to understanding the structure of biological neural systems to build better analysis tools and for application to social networks to better model them for analysis. An understanding of these principles may apply to understanding underlying patterns in the mass of data collected for geospatial intelligence.

8.19. Cold Atom Optics

POC: Steve Malys, 301-227-7452 (NGA)

Background

The physics discipline of Cold Atom Optics capitalizes on the wave nature of atoms and consists of tasks such as cooling, trapping and manipulating atoms with lasers, magnetic fields and electric fields. The laser cooling techniques that received a Nobel prize in 1997 are now being

used to explore new measurement types and advance our understanding of the quantum physics processes at work in laser cooled matter. This discipline is an active area of basic research. A significant amount of applied research at several U.S. institutions is also underway.

Research Proposal

Possible practical applications of this discipline include advancements in:

- a) Guidance and navigation, including inertial force sensors and frequency standards,
- b) New classes of sensors and detectors for gravity gradients and magnetic signatures

A Post-Doctoral candidate in this discipline will acquire and build skills in manipulating laser-cooled matter. These skills can be applied toward several intelligence community problems.

8.20. Gravity and Magnetic Gradiometry

POC: Steve Kenyon, 314-263-4080 (NGA)

Research Proposal

The research proposed under this effort will focus on the mathematical analysis and interpretation of the information contained in the gravity and magnetic gradient tensors. The research will include specific emphasis on subsurface modeling, terrain modeling, mass and magnetic anomaly detection and characterization. Inverse theory, gravity and magnetic field modeling, computational methods and algorithms, and signal analysis, among others are key areas of study. A series of mathematical and visualization tools, will be examined and/or developed with a goal of extracting the maximum amount of geospatial information from the gravity and magnetic gradient tensors. The specific man-made and natural subsurface structures to be studied will be coordinated with the IC advisor.

8.21. Non-Visual Spectral Imaging Processing

POC: Greg Boer, 202-264-5503 (NGA)

Background

NGA continues to explore and expand on their understanding of non-literal spectral processing, exploitation, and analysis (PEA) capabilities to solve enduring and emerging problems. Non-literal describes any technique that is based on a mathematical algorithm or a non-visual system, as opposed to one that is based on human visual perception. These non-literal PEA capabilities and sources need to address multiple applications of interest to NGA and the Intelligence Community. These capabilities must be robust, user-friendly, highly automated, and reliable. PEA capabilities of interest would include, but not be limited to, non-linear sub-pixel and mixed pixel detection and identification, modeling spectral/signature variability, and background-

foreground separation of solids, liquids, and gases.

Research Proposal

NGA is requesting research in new methods and techniques to derive geospatial intelligence and develop advanced PEA tools from unique spectral sources. Consideration will be placed on offerers exhibiting unique synergistic PEA methods and techniques utilizing complementary sources (Spectral, SAR, LIDAR, etc.) yielding high value geospatial intelligence. Exemplar research projects are automated land surface, environmental, and mineral mapping applications via dynamic spectral library matching of hyperspectral imagery and SAR data.

8.22. Automated Change Detection

POC: Tom Black, 703-808-5296 (NRO)

Background

New techniques have revealed geophysical changes to surface topography in well-known regions of tectonic activity (see reference). These techniques allow vertical land displacements to be measured and monitored over time. Results from such data processing also support the interpretation of the causes for such displacements.

Using data acquired on orbit, new methods will continue to provide processing that will discover and support monitoring of vertical surface changes (and other changes) whether caused by natural processes or man-made activity. Future missions will collect phase history data over vast areas of the earth, with the potential of hundreds of thousands of square kilometers being collected each day. In order to focus limited processing and analysis resources, it will be critical that effective automated change detection methods be operational to alert on natural or man-made changes of high interest. This will be particularly critical for the identification of recent changes not in areas under continual monitoring based on past change discovery.

Research Proposal

Such automated techniques must have very low false alarm rates, yet provide high probabilities of detection. Current techniques are not sufficiently robust to provide such functionality. It is recommended that research be conducted to survey existing and potential methods to perform automated change detection using various data and enhance these techniques or to develop new capabilities to address this problem area.

8.23. Rapid Exploitation of SRTM DTED

POC: Davidson Chen, 703-808-4916 (NRO)

Background

The Shuttle Radar Topographic Mission (SRTM) finished Digital Terrain Elevation Data (DTED) has just become available from NGA. The global data is available to approved users on approximately 100 DVDs. Many applications that would exploit this level-2 DTED data will require fast interpolation of the vertical elevation(s) associated with a point(s) of interest.

Research Proposal

This investigation would examine ways to host and exploit this data set for rapid operational use. The study may include both methods to structure an efficient database hosting the SRTM data as well as methods for interpolating within the database to compute elevations for arbitrary points.

Period of Performance: This research topic is envisioned as a 1-year effort.

8.24. High Frequency applications of Carbon Nanotubes

POC: Vince Ballarotto, 301-935-3147 (NSA)

Background

Currently there is a strong interest in creating high-frequency (HF) devices with nanotubes. Recent demonstration of carbon nanotube devices working at microwave (GHz) frequencies means that the potential for creating passive HF nano-scale components is real. In addition, single-walled carbon nanotubes have recently been grown to approximately a centimeter in length, suggesting nano-scale antennas may be possible. However, the electrical properties of HF components fabricated from nanotubes are not completely understood. Thus, research needs to focus on understanding and characterizing HF behavior of nanotubes.

Research Proposal

Ideas are solicited that test, characterize or utilize HF behavior of nanotubes. Any approach that investigates nanotube behavior from rf to microwave frequencies will be considered. A method that can lead to the development of a wireless connection between a nanoscale device and a macroscopic one would be considered significant. The insight gained from investigating nanotube HF behavior should lead to practical application.

8.25. Nanoscale Spectroscopy of Qubits for a Solid-State Quantum Computer

POC: Barry Barker, 301-935-6464 (NSA)

Background

Quantum computers have the potential to revolutionize tasks of national interest such as searching databases and factoring large numbers. Solid state implementations provide the best long-term prospects for production of a scalable quantum computer that meets national security requirements. The fundamental unit of a quantum computer, the qubit, is always a nanoscale object (*e.g.*, the charge on a quantum dot, the polarization of a photon, or the nuclear spin state of an individual atom). The ability to utilize the quantum nature of these qubits requires intimate knowledge of the nanoscale environment of the qubit. Spectroscopic measurements using the atomic resolution of scanning tunneling microscopy (STM) can provide exactly that knowledge. In addition to high resolution in energy and high spatial resolution, STM also produces the ability to directly modify the environment surrounding a potential qubit.

Research Proposal

The development of very-low temperature scanning tunneling microscopy/spectroscopy opens a large window on the nanoscale environment of many solid state materials. Studies of various dopant/semiconductor systems then provides a direct evaluation of the feasibility of integrating such a system into a quantum computer. Several thrusts involve collaborations both within LPS and with scientists around the world including at the University of Maryland and the University of New South Wales (in the Centre for Quantum Computing Technology). If awarded, the DCI Postdoctoral Research Fellow would be responsible for the integration of the VLT-UHV-STM and initiating the following scientific studies:

- **STM/STS studies of dopants in silicon** – Probe the energy levels and spatial structure of the electronic states near donors in silicon (one potential qubit). Examine the variation of these properties with magnetic field, donor atomic species, donor-donor distance, and temperature. By operating below 0.1 K, it becomes possible to spectroscopically resolve the hyperfine states of the donor, thereby probing the nuclear spin state of the donor (another potential qubit state).
- **STM/STS studies of dopants on hydrogen-passivated silicon** – Duplicate the above measurements for dopants on the surface of passivated silicon. This allows the direct manipulation of the positions and types of donors (*e.g.*, P, Te, C₆₀, *etc.*).

Building a quantum computer is a breathtakingly ambitious endeavor. In-depth study of each proposed system must produce a plan – from building an individual qubit to full-scale system integration into a useful computing machine. These spectroscopic studies will provide the wider scientific community with detailed knowledge concerning the feasibility of and engineering necessary for building a silicon-based solid state quantum computer. The DCI Postdoctoral Fellow will thereby aid the Intelligence Community in determining the optimal path to quantum computation.

8.26. Process-Based Social Networks

POC: Curt Boylls, 443-479-7230 (NSA)

Background

Social network analysis (SNA) makes rigorous many heuristics that intelligence analysts have long employed to make inferences about human enterprises and their constituent components. Analysts in turn have taken SNA methodology and extended it very effectively to other network types—communications and transportation networks, for example. To date, however, SNA has largely been predicated on the geometric properties of such networks when they are rendered as entity-relationship diagrams or graphs. Investigators such as Pregibon endeavored to study “communities of interest” that reveal themselves in the behavioral dynamics of networks (example: the flows and directions of communications among nodes), but this work has had limited utility to date in the Intelligence Community.

What is missing in SNA, we believe, is the notion of “processes” that live within the nodes of the network and that account for the transactions that we see among nodes. A classic illustration of our point can be found at the Netherlands Interprocs website (www.euridis.nl/?view=Interprocs). Interprocs is a modeling system for international commerce. Each “node” in an Interprocs network is some actor in international trade (banks, consumers, suppliers, shippers, etc.). Each actor is modeled with a Petri net that sends and receives tokens (transactions) to/from other actors.

Research Proposal

Given the transactions generated by an Interprocs model, we will recover the Petri nets associated with each actor in the model and deduce whether these nets have the potential for multiple regimes of behavior.

We can readily discuss a sequence of research goals, and methods for moving the work from Interprocs “toys” to real situations with high intelligence interest.

8.27. Optimization for Collaborative Analysis

POC: Gary Kuhn, 443-479-7220 (NSA)

Background

Each intelligence analyst has a mandate to work on specific topics. Work on each topic is based on specific information sources. Some sources are available at many intelligence agencies, while others may be available at only a single agency. Within an agency, only a subset of analysts may have clearance to access a given source. Within or across agencies, the tools which the cleared analysts can use to exploit the accessible sources may well be different.

Many analysts across the intelligence community contribute to work on broad topics. For example, many analysts track bio-warfare related activity in certain countries. Sometimes these

analysts put their findings in databases for other analysts. Other times they put their findings in databases for policy-makers or warfighters. In this environment of overlapping but non-identical information sources, clearances, tools and reporting, a lack of coordination or collaboration can be costly. Sources may be mined only to find information which was already known. Sources may not be mined for information whose value was known elsewhere to be key. Increase the collaboration, and analysts may recognize that certain information is needed right now and may be useless tomorrow. In general, they can do a better job of mining the available information in proportion to its ability to add value.

Research Proposal

A value for information can be calculated by a mathematical model. The modeled value can be confirmed or disconfirmed by the consumers of the information, e.g., by the policy-makers or warfighters mentioned above. Whenever confirmation or disconfirmation is available, credit for good valuations or blame for bad valuations can be assigned, and the model can be improved. This iterative process of model improvement is called “optimization.”

The objective of this proposal will be to design a cost function to optimize a model for a combination of deterministic and probabilistic information retrieval tools, and for a set of intelligence community analysts with overlapping mandates.

The goal of this proposal will be to implement such a cost function on a test vehicle, e.g., on the BLACKBOOK system, and to assess the rate and the integral of information discovered, both with this optimization and without it. The ideal candidate will be a mathematical programmer with experience in optimization or “machine learning” and an interest in intelligence analysis.

8.28. Fluorescent Nano-Particles for High Efficiency Sensors

POC: Bill Vanderlinde, 301-935-6467 (NSA)

Background

There is considerable interest at present in developing highly efficient fluorescence-based sensors which might be used in the detection of very small levels of certain proteins or DNA. Labeling of enzymes or complimentary strands of DNA with fluorescent dyes or “fluorophores” has the advantage of selectivity for a particular target molecule or agent, however achieving the desired level of sensitivity, making the realization of practical field-based, real-time detection systems technically challenging. Photobleaching irreversibly deactivates fluorophores at too large an incident light intensity setting a limit to the signal achievable by merely illuminating the sensor with a very bright source. Background signal and signal-to-noise considerations on the other hand limit the efficacy of amplifying a very weak fluorescent signal optoelectronically

Research Proposal

An appealing candidate technique for overcoming these limitations is metal-enhanced fluorescence (MEF), also referred to as surface enhanced fluorescence (SEF). It is observed that

the ratio of the fluorescently emitted photon intensity to the incident intensity is enhanced if the fluorophores are in close proximity to certain metal particles of nanometer-scale dimensions. Measurements indicate that proximity of fluorophores to nano-particles produces increased fluorescent intensity and quantum yield while reducing the fluorescent lifetime. These effects combine to increase the photostability of the molecules, a desirable effect in a sensor application. Possible applications include improved portable sensors for bio-hazards.

8.29. Trusted Information Sharing Research Program Area

POC: Ted Wackler, 703-874-2355 (ITIC/ISB)

Background

In a recent study of the subject of Trusted Information Sharing, the Director of Central Intelligence (DCI's) Intelligence Science Board (ISB) observed that the Intelligence Community is not doing an effective job of "sharing information *about* information sharing. TIS entails a vast array of issues across a multitude of academic disciplines (technical, organizational, social, and legal) that must be orchestrated in concert if the Community is to improve its ability to share vital information amongst itself and with its evolving customer base.

Research Proposal

Research is requested to address organizational, legal, cultural, social, and human factors that are central to effective information sharing across and among enterprises, including:

1. How is information sharing feasible, without leading to information overload for the human consumer?
2. How should government policies be changed to facilitate information sharing while preserving civil liberties?
3. How should the enterprise properly incentivize (and facilitate) information sharing organizationally and individually?
4. How can the true value of effective information sharing be properly measured and assessed within and among enterprises?
5. How can risk management of information sharing be properly and continuously implemented?
6. How should all the multiple disciplines relevant to trusted information sharing be properly cross-pollinated and coordinated?

Research is requested to address technical mechanisms and approaches to sharing information in a trusted manner across and among enterprises with related but not identical organizational goals and constraints, including:

1. How can information sources and methods be assuredly separated from information content?
2. What kind of metadata management process will be required to enable information sharing?

3. How can widely shared information be properly vetted (e.g., confidence levels maintained)?
4. How can cross-boundary information sharing be properly protected (to be trusted), especially in an automated environment?
5. How can previously shared information that is subsequently invalidated be retracted?
6. How might marketplace principles be applied to govern a cross-enterprise information sharing process?

Recognition is also sought for the need of a broader perspective to result in scalable integrated solutions that can actually work in a government environment that must share *and* protect sensitive information.

8.30. Detection and Recovery of Steganalysis and Data Hiding

POC: George Dumais, 703-874-3293 (ITIC)

Background

In the Intelligence Community, there has been a proliferation of novel methods of hiding information in static and dynamic data fields over the past few years. Research into methods for detection of the use of steganography and other data hiding techniques, and the subsequent recovery of hidden data, has lagged in comparison. Effective, robust general methods of steganalysis have not been developed for applications in Intelligence.

Research Proposal

Under this proposal, the focus of this postdoctoral effort will be on the investigation of the theoretical foundations of steganalysis and other types of data hiding and the development of a solid theoretical approach to the problem of steganography detection. Applications will be solicited for postdoctoral fellows that emphasize the theoretical underpinnings of steganography research. Consideration may also be given to the investigation of methods for combining general techniques with methods specific to various file formats and data protocols, so as to produce optimized detection methods for particular cases. Specific goals of the proposal should address the measures of probability of detection versus false positive rates and the development and testing of algorithms to evaluate the computational efficiency of proposed methods. If progress warrants in the area of detection problems, subsequent goals should aim to develop methods of extraction of hidden data.

9. SIGNIFICANT DATES

The following table provides the significant dates referred to in the body of this announcement.

| <u>Action</u> | <u>Responsibility</u> | <u>Due Date</u> |
|--|------------------------|------------------|
| Issue announcement | Government | 14 February 2005 |
| Proposal due | Principal Investigator | 1 April 2005 |
| Acknowledge receipt of proposals | Government | 11 April 2005 |
| Letter of intent to recommend for award and declinations | Government | 25 May 2005 |
| Estimated start date | Principal Investigator | 1 July 2005 |
| DCI Postdoctoral Colloquium (required attendance) | Government | April 2006 |

9.1. Late Submissions

Proposals will be considered for award if submitted timely. If a proposal is submitted in an untimely manner, after 5:00 P.M. (Eastern Daylight Savings Time) on, 1 April 2005 the criteria in Federal Acquisition Regulation part 15.208 will be adhered.

POINTS OF CONTACT

9.2. Grants and Contracting

Ms. Terri A. Scheid at 703-735-3122.

9.3. Administrative Issues

Dr. Scott Loomer at 703-735-3062.

Mr. Tom Kennedy at 703-874-0689.